Bioactive Carbohydrates and Dietary Fibre 30 (2023) 100356

Contents lists available at ScienceDirect

Bioactive Carbohydrates and Dietary Fibre

journal homepage: www.elsevier.com/locate/bcdf

A review of the health benefits, functional properties, and ultrasound-assisted dietary fiber extraction

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ARTICLE INFO

Keywords:
Dietary fiber
Ultrasound-assisted extraction
Functional properties of dietary fiber
Health benefits of dietary fiber

ABSTRACT

Dietary fibers are primarily complex carbohydrates and a potential class of compounds that offer numerous health benefits. Dietary fiber has several therapeutic and nutraceutical benefits because of its functional characteristics. It can be extracted from plant resources using different methods like enzymatic, thermal, and chemical. These methods have major drawbacks such as low extraction yield and low quality. Extraction using ultrasound techniques has been implemented to enhance the extraction yield and quality with a substantial drop-in process time and power consumption. Ultrasound can improve many functional properties of dietary fiber like water holding capacity, gel-forming capacity, oil holding capacity, and other characteristics. This review emphasizes the advantages of ultrasound-assisted extraction over other extraction methods for different types of dietary fiber compounds extracted from different plant sources with the difference in their processing parameters. This review also discusses the nutritional and functional properties of dietary fiber.

1. Introduction

The edible components of plants that cannot be digested or absorbed in the small intestine and move into the large intestine are called dietary fiber or “roughage" (Dai & Chau, 2016). Defining dietary fiber and putting a wide number of compounds under this umbrella word has been a source of worry for the past few decades. For scientific and/or regulatory purposes, many scientific groups have endeavored to offer a clear definition. In 1953 Hipsley used the word dietary fiber to describe the non-digestible components of the plant cell wall. Trowell and Burkitt proposed the initial definition for dietary fiber in 1972–1976. AACC (Association of Cereal Chemists) published a scientific definition in 2001, stating that “Dietary fiber are the carbohydrates that are resistant to digestion and absorption in the human small intestine and ferment completely or partially in the large intestine”. From the above definition, it is concluded that dietary fiber is a plant-derived oligosaccharide or polysaccharide that the human digestive system cannot completely digest. It consists of cellulose, lignin, hemicellulose, pectins, oligosaccharides, waxes, and gums (Dhingra et al., 2012). Dietary fiber is considered an important component of plants. It consists of diverse chemical structures resistant to digestion by human digestive enzymes (Williams et al., 2019). Because of the importance of dietary fiber, a significant and potential market for fiber-rich foods and components has developed. In recent years, there has been a drive to uncover novel sources of dietary fiber that may be employed in the food business (Dhingra et al., 2012). Dietary fibers are classified as soluble and insoluble fibers based on their solubility (Daou & Zhang, 2013). The classification of dietary fiber as soluble and insoluble fiber is given in Fig. 1.

The physical, chemical, and functional properties of dietary fibers depend largely on the type of method used for extraction (Nadar et al., 2018). The extraction of dietary fiber is done by various methods such as chemical, mechanical, thermal, enzymatic, etc. These methods, however, necessitate extended extraction durations and high temperatures, resulting in low extraction yields. As a result, novel extraction methods have been developed. Ultrasound-assisted extraction (UAE) is one of them (Kumar et al., 2021). UAE offers benefits like reduced time and energy consumption, low-temperature extraction, and the preservation of extract quality. UAE uses high-intensity sound waves to extract dietary fiber from plant sources (Valencia-espinosa et al., 2023). The physical forces created during acoustic cavitation cause disruption in plant tissue, which aids in the release of extractable components in the solvent in a less amount of time (Singla & Sit, 2021). From the application and commercial point of view, the ultrasonic part of the spectrum

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https://doi.org/10.1016/j.bcdf.2023.100356
Received 28 October 2022; Received in revised form 10 February 2023; Accepted 19 March 2023
Available online 14 May 2023